NAWS MOHAVE TUI CHUB ANNUAL REPORT FOR 2002

1.0 Background Information

1.1 Lark Seep System

The City of Ridgecrest's Waste Water Treatment Facility (WWTF) evaporation and percolation ponds, existing on the Naval Air Weapons Station (NAWS), China Lake since 1945, elevated the already high groundwater mound and resulted in the establishment of Lark Seep. In order to control the expansion of Lark Seep, and to encourage water to flow away from nearby structures and test sites, a system of channels was created. The channels direct the day-lighting groundwater away from NAWS, China Lake facilities out to the China Lake playa, where G1 Seep formed. This network of channels and seeps is referred to as the Lark Seep System.

1.2 Mohave Tui Chub History

The Mohave tui chub (*Gila bicolor mohavensis*) were historically restricted to the Mojave River, from the confluence of the east and west forks at the base of the San Bernardino Mountains to its terminus at Soda Dry Lake. Habitat modifications, including damming of the headwaters and withdrawals of the river's underflow, were major causes of the decline of the species. Due to this decline of the species, the Mohave tui chub were listed as endangered by the US Fish and Wildlife Service (USFWS) in 1970 and by the California Department of Fish and Game (CADFG) in 1971. Due to the lack of natural habitat the CADFG and the USFWS established refuges for the rapidly disappearing fish. NAWS China Lake was chosen as a refuge site and the Mohave tui chub were introduced into Lark Seep in 1971. Currently, the chub do not exist in their natural habitat within its native range with the possible exception of one small spring adjacent to Soda Dry Lake.

Genetically pure populations of chub now exist at refuge sites at the NAWS China Lake, Soda Springs (Zzyzx) southeast of Baker, and Camp Cady, which is maintained by the CADFG.

1.3 Previous Mark-Recapture Surveys

Since 1995, annual mark-recapture surveys have been conducted to estimate the chub population at China Lake. From 1995 through 2000 the project was conducted during the last weekend in May or first weekend in June. However, spawning fish were encountered during that time period. In 2001 the survey date was moved to November with hopes of decreasing the risk of encountering spawning fish and resultant egg loss due to handling. No spawning fish were encountered during the 2001 mark-recapture survey; however, the second survey day resulted in low recapture numbers. Due to the nature of the Lincoln-Peterson calculation used to analyze the data the low recapture numbers resulted in a confidence interval close to the population estimate. Therefore, there is little validity to the population estimate calculated for 2001.

Table 1 shows the estimated population number and confidence interval for each year.

Table 1. Population estimate and confidence interval for 1997, through 2001 surveys.

Year	Population estimate	Confidence interval
1997	8192	4281
1998	7185	4292
1999	6815	2277
2000	3143	672
2001	10406	10021

2.0 2002 Projects

2.1 Water Monitoring.

Two 24-hour water quality meters have been installed along the Lark Seep System.; One meter is stationed at the Bologna Pool and the other is in the deeper waters of the North Channel in the enhanced habitat area referred to as Chub Med. Both meters monitor pH, dissolved oxygen, temperature and conductivity. Information for each parameter is recorded every 30 minutes and is stored in the data recorder for up to one month before being downloaded into a portable computer. The analysis of the 24-hour data provides a detailed characterization of the water quality in these two habitats. Figures 1-4 show detailed water quality characteristics of the Chub Med habitat.

2.2 Cattail Removal

NAWS China Lake rented an extended reach excavator to assist in the annual cattail removal process. The removal was completed in late December 2001 and early January 2002. With the help of the extended reach excavator many areas, that were previously inaccessible, were cleared. All removal efforts were conducted in accordance with guidelines established in the biological opinion (1-8-97-F-39R).

2.3 Tamarisk Removal

The plant genus Tamarisk is comprised of approximately 54 species native to North Africa, the Mediterranean, and the Middle East. Common names include tamarisk and salt cedar. This invasive plant has overrun riparian ecosystems in arid and semi-arid regions of the southwest. Tamarisk establishes in disturbed and undisturbed streams, waterways, bottomlands, banks, and drainage washes of natural or artificial water bodies, moist rangelands and pastures, and other areas where seedlings can be exposed to extended periods of saturated soil for establishment.

Tamarisk usually out-compete native vegetation by changing the site's soil and hydrologic characteristics. The root system is deep rooting and one large tree can take up 200 gallons of water per day. Dense thickets of tamarisk promote flooding by blocking water channels. Tamarisk eliminate excess salt from their systems by exuding it through the tips of their leaves. When the leaves are shed, this excess salt increases the salinity of the surrounding soil.

From a wildlife point of view, tamarisk have little value and are usually considered detrimental to native animals. Tamarisk generally provide unsuitable habitat for most wildlife because neither its foliage nor it flowers and seeds have any significant forage value. From a structural standpoint it does provide some cover for some species, particularly birds. In spite of this cover value, most experts conclude that tamarisk has little value to native wildlife.
During September 2002, tamarisk was removed from areas around the North Channel and the Bologna Pool. The tamarisk's woody material was removed using a large excavator. It is recognized that there will be many new recruits next season due to seed dispersal during this year's tamarisk removal. However, the smaller recruits will be easier to treat with the "cut stump and herbicide application" method planned for 2003.

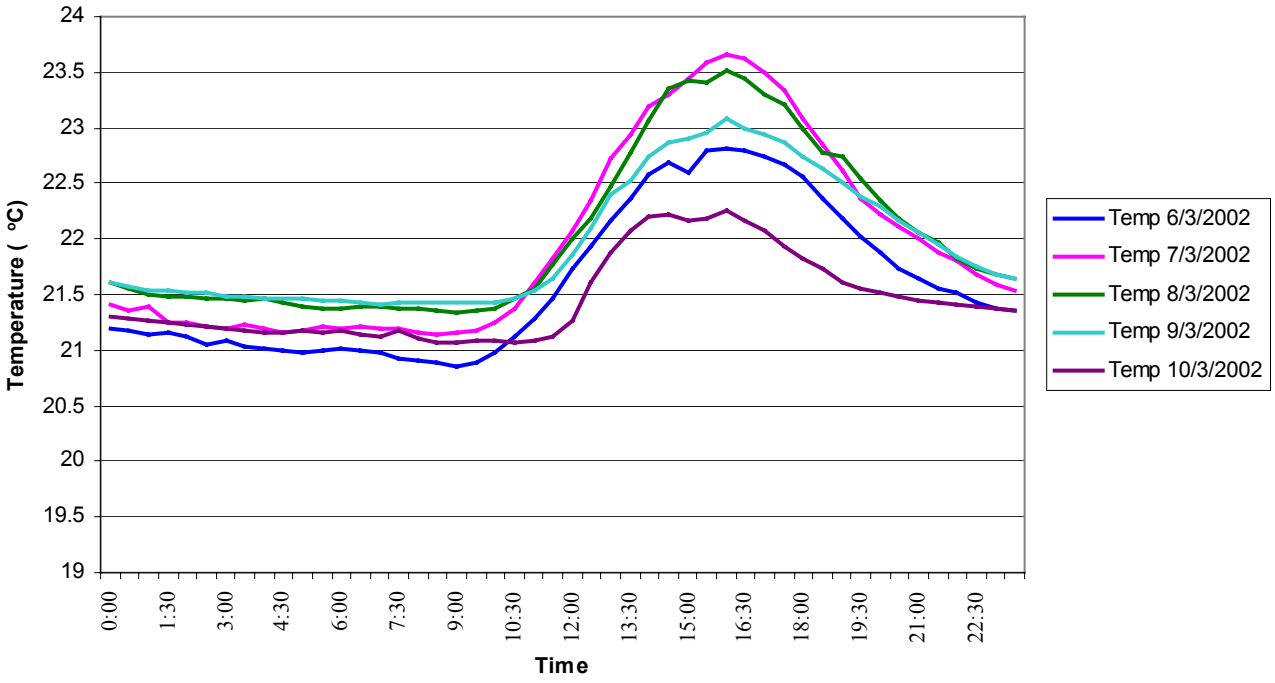


Figure 1: Temperatures (°C) at Chub Med for June Through October 2002

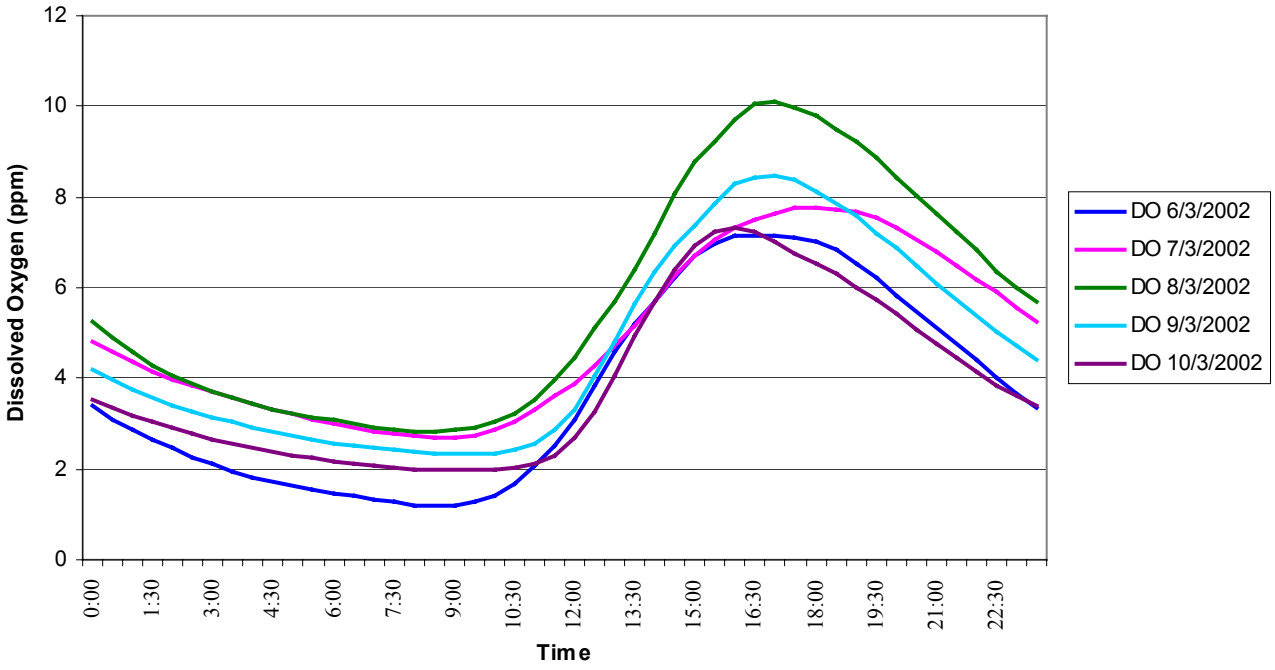


Figure 2: Dissolved Oxygen (ppm) levels for June through October 2002 at Chub Med

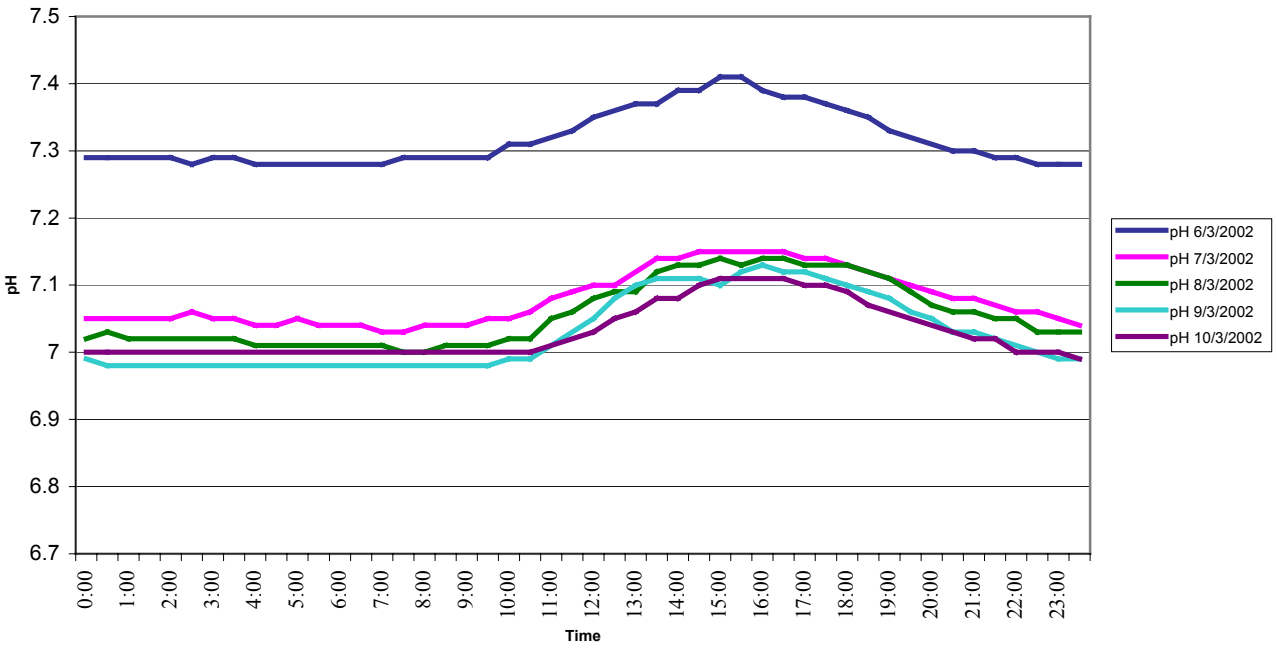


Figure 3: pH Values for June through October 2002 at Chub Med

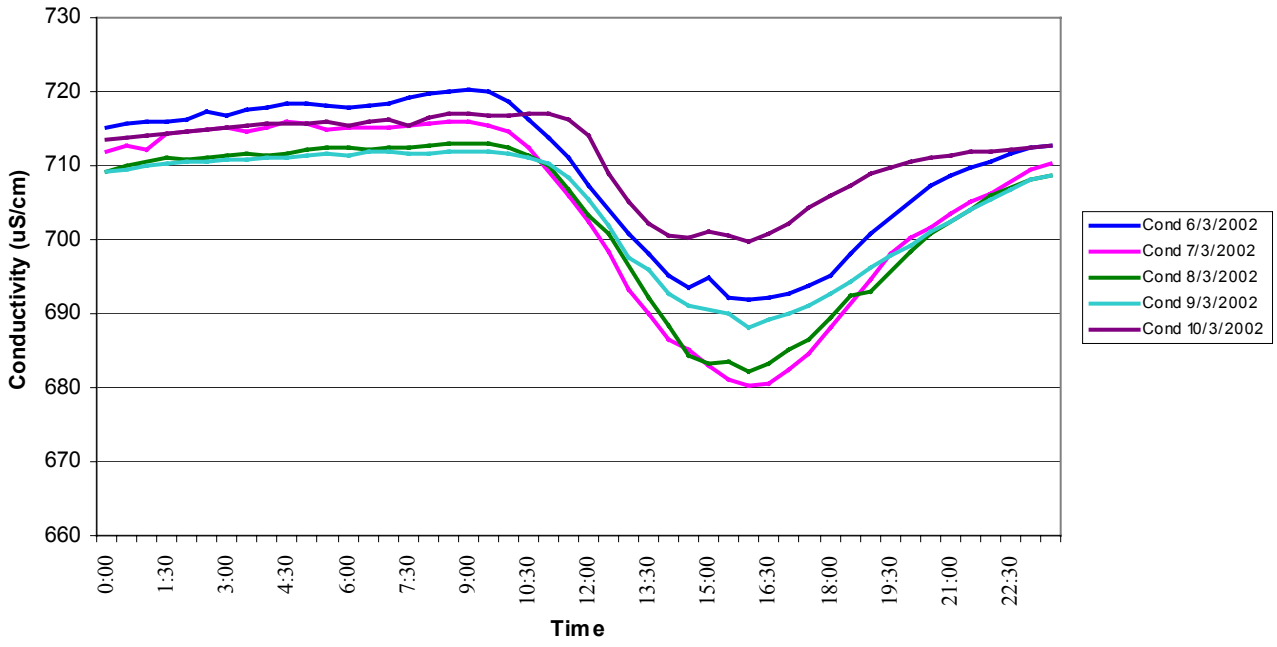


Figure 4: Conductivity (uS/cm) for June through October 2002 at Chub Med.

2.4 Habitat Designation

To obtain more reliable population estimates, it was decided to divide the Lark Seep System into various habitat types. In the determination of habitat types the defining features were depth and width of the channels, as well as the existence of contiguous habitat. While designating different habitat types it was determined that some areas in the Lark Seep System were not suitable for sustaining a viable chub population. For example, there is a length of channel, from the west side of George Road to G1 Road, characterized by numerous intermittent shallow areas and changes in channel bed elevation leaving little contiguous habitat (Map 1). Historical trap sites 8 and 9 were located along this length of channel. The average number of fish caught at historical trap site 8 was less than 10 and at historical trap site 9 the water became too shallow to submerge the trap. Because of the poor habitat and historic population survey data showing few captures, traps will not be placed in this channel during future population surveys.

The three remaining habitat areas are the North Channel (Map 2), the channel east of George Road (Map 3), and the channel east of G1 Road (Map 4). The L-shaped North Channel begins parallel with Water Road and widens at the culvert where water flows in from the Bologna Pool. The channel then proceeds approximately 775 feet to the north. Two hundred feet north of the Water Road culvert the channel was widened to approximately 25' across and 10 feet deep creating the enhanced habitat referred to as Chub Med. This part of the channel extends for approximately 250 feet. The channel then narrows down to approximately 19 feet wide with an approximate depth of 3.5 feet for approximately 300 feet before widening and pooling at the end (Mystery) culvert. Cattails clumps are dotted along the channel length. The channel banks are partially vegetated with pickle weed, salt grass, *juncus* and some tamarisk.

The channel east of George Road is approximately 1,322 feet long and is a narrow, shallow, v-notch channel approximately 15 feet across at the widest point with an average depth of four feet. A large field of cattails exists between Lark Seep and the George Road channel with no obvious connecting channel; however, water flows quickly into the inlet at the east end of the channel. *Juncus* grows in the shallow water at the inlet and the rest of the channel supports a mixture of cattail and *juncus* clumps.

The G1 channel's widest point is 18 feet with an average depth of 3 feet with cattails growing only at the beginning and at the end of the channel. The channel is approximately 500 feet long with a uniform, wide bottom shape. The end of the channel opens into a pond with dense cattail growth all around and is the beginning of G1 Seep.

Depending upon the seasons and ambient temperatures the water in the channels can be clear or have a prominent surface and subsurface algal bloom. The water in the North and G1 channels appears clearer than the water in George Road channel, which often appears rust colored due to dissolved organic acids.

3.0 Population Calculations

3.1 Lincoln-Peterson

The Lincoln-Peterson method was historically (1995-2001) used to estimate the Mojave tui chub population at NAWS China Lake. The recapture rate is a significant factor in determining accurate population estimates using the Lincoln-Peterson calculation. The results of the statistical analysis of previous mark and recapture survey data had very large confidence intervals due to the low numbers of

recaptured individuals. Large confidence intervals leave the results of population estimate calculations ineffectual for estimating the true population of the Mohave tui chub at NAWS, China Lake.

3.2 POPAN-5

To analyze the data from the 2002 Mark-Recapture surveys POPAN-5 from the University of Manitoba was used. POPAN-5 is a data maintenance and analysis system for mark-recapture data and integrates many different methods of census calculations. POPAN stands for POPulation ANalysis. POPAN-5 is a computer system for creating and maintaining files of mark-recapture data from animal sampling experiments of open populations. Statistics can be extracted from the entire file or subsets of the file, and a number of standard analyses can be carried out. PROPAN-5 is designed to maintain the complete data from an experiment together, including not only data on individual or batch histories, but also the meta-data on animal attributes and sample time characteristics. Meta-data is information that describes data, such as the units of measure. The user can then split out subgroups of animals and subgroups of the sample times for individual or comparative analyses. POPAN-5 also has extensive data checking to ensure that the raw data read in is consistent with the meta-data.

The Schnabel-Darroch model was chosen to analyze the 2002 mark-recapture survey data. The Schnabel-Darroch census is a commonly used survey method in which individual members of a countable population are repeatedly sampled, noting the presence or absence of each individual. The duration of a Schnabel census is typically short so that individuals are unlikely to enter or leave the population during the survey.

4.0 2002 **Mark-Recapture Survey**

4.1 Dates

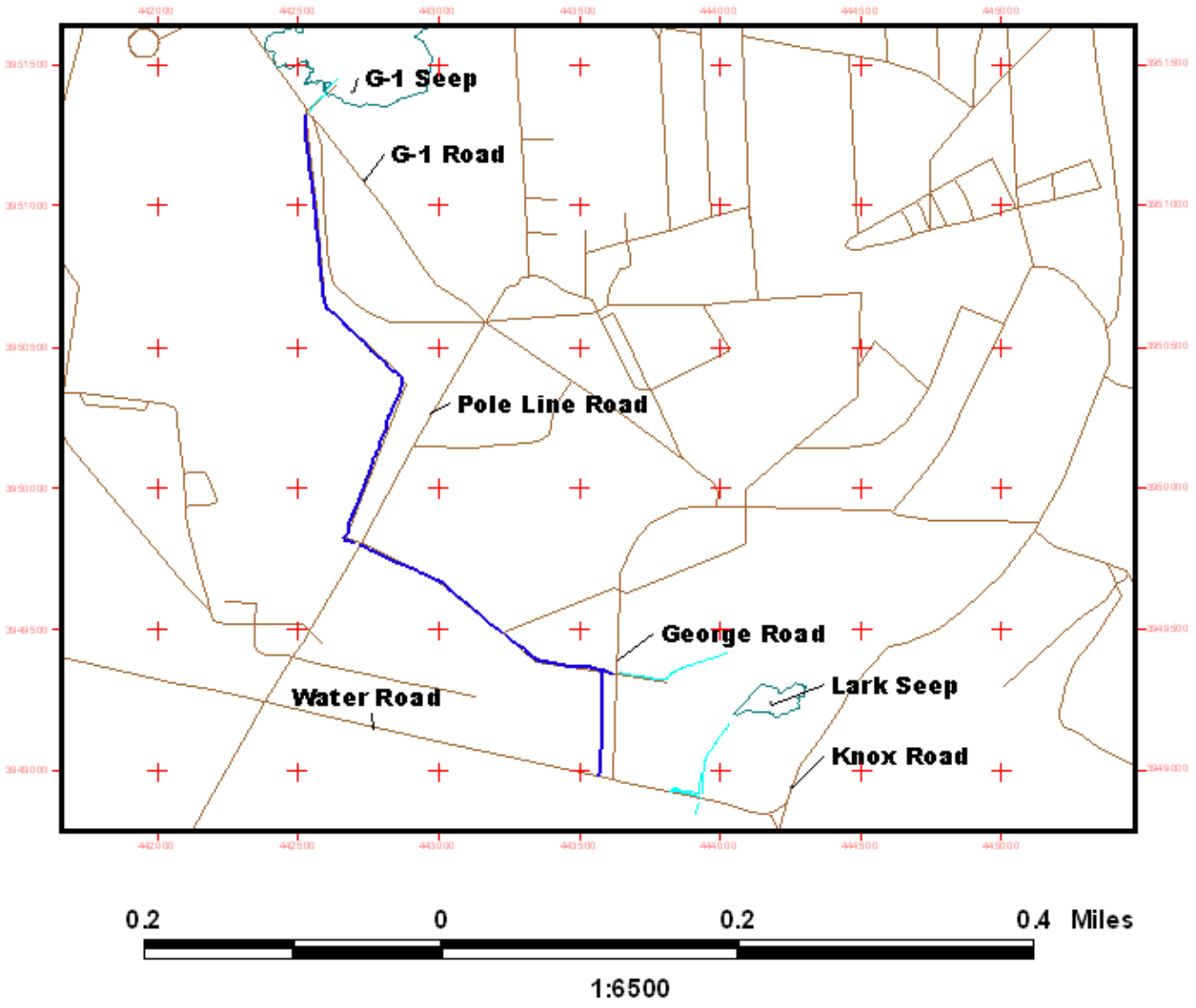
The 2002 mark-recapture survey started on Monday, October 7, 2002 and ended on Thursday, October 10, 2002.

Previous surveys in late May or early June resulted in the inadvertent capture of spawning fish. In response, air and water temperatures were compared, and it was decided that late October or early November had similar favorable trapping conditions with a much lower risk of capturing spawning fish. Therefore, the 2001 survey was conducted 12-14 November. No spawning fish were trapped in 2001, but ambient temperatures were somewhat cooler than temperatures for past surveys conducted in the spring. For 2002, it was decided to conduct the survey in October, when ambient temperatures should be even closer to that of the original trapping sessions.

4.2 Marking Scheme

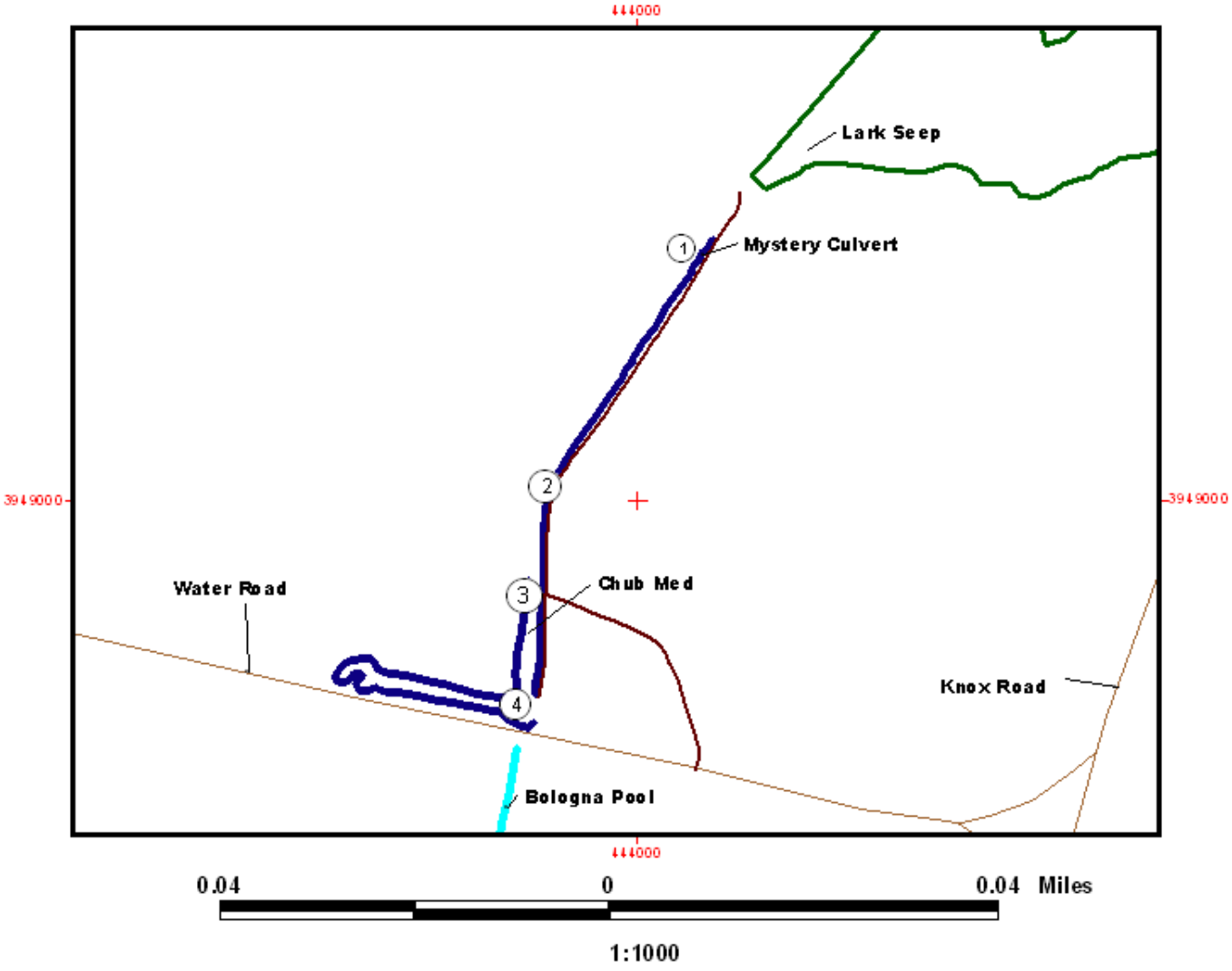
For the 2002 survey the USFWS approved (in an amendment to the Biological Opinion 1-8-97-F-39R, NAWS, China Lake, Kern County, California) the use of Visible Implant fluorescent Elastomer (VIE) marking methods instead of fin clipping for marking the chub. The VIE method has been shown to be more reliable than fin clipping and results in less mortality. Based upon previous trials on non-listed chub species, the method has reliable retention rates, provides distinct visual marks, and can be easily and quickly applied to a chub's head and jawbone. Fish from each habitat type were marked with a different color (i.e: North Channel mark pink, George Channel mark orange, and G1 Channel mark yellow). The new marking method will allow data to be gathered on chub movement as well as longevity.

Map 1. Channels with Limited Habitat



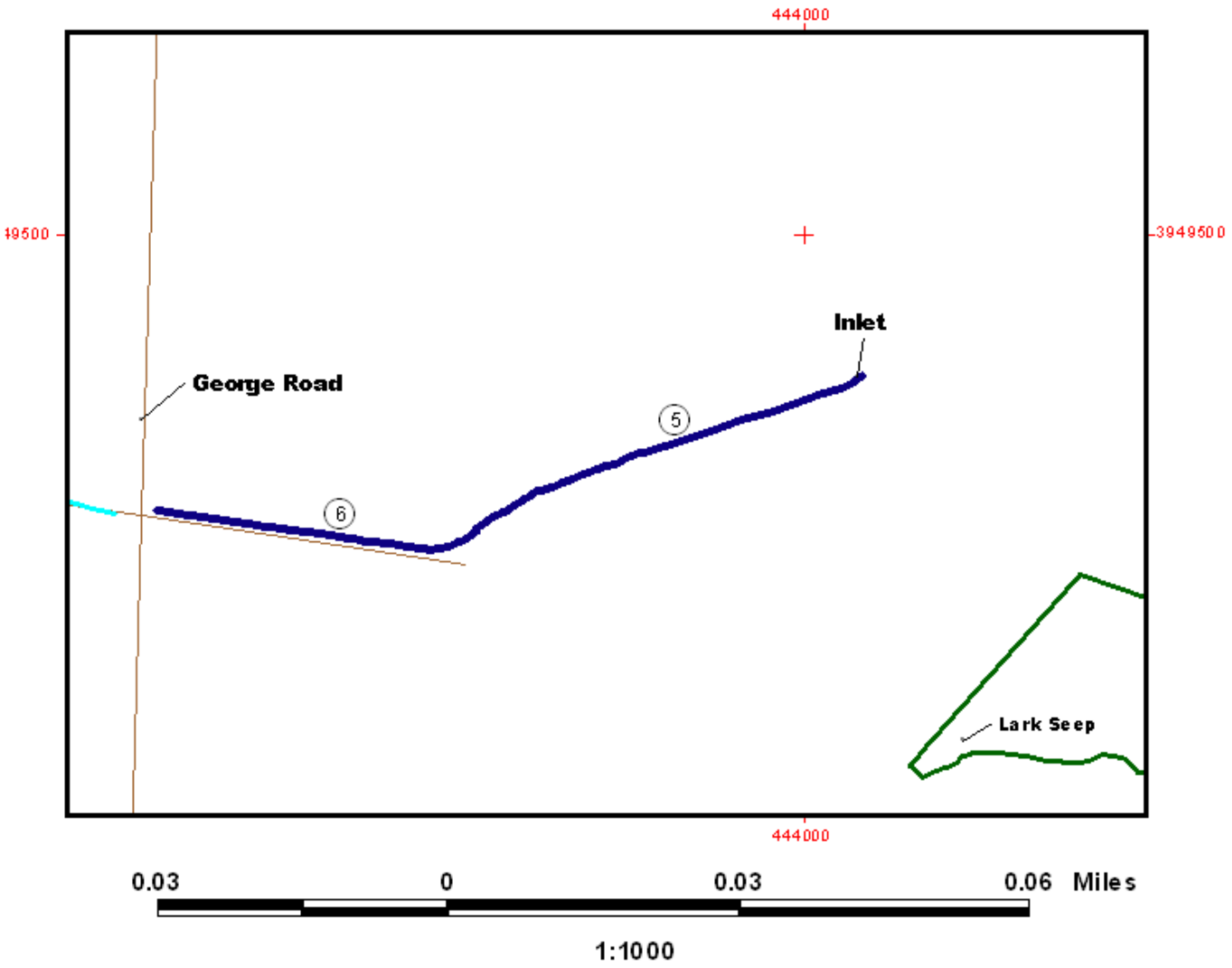
Map by Erica Nevins, Epsilon Systems Solutions 2002

Map 2. North Channel Habitat



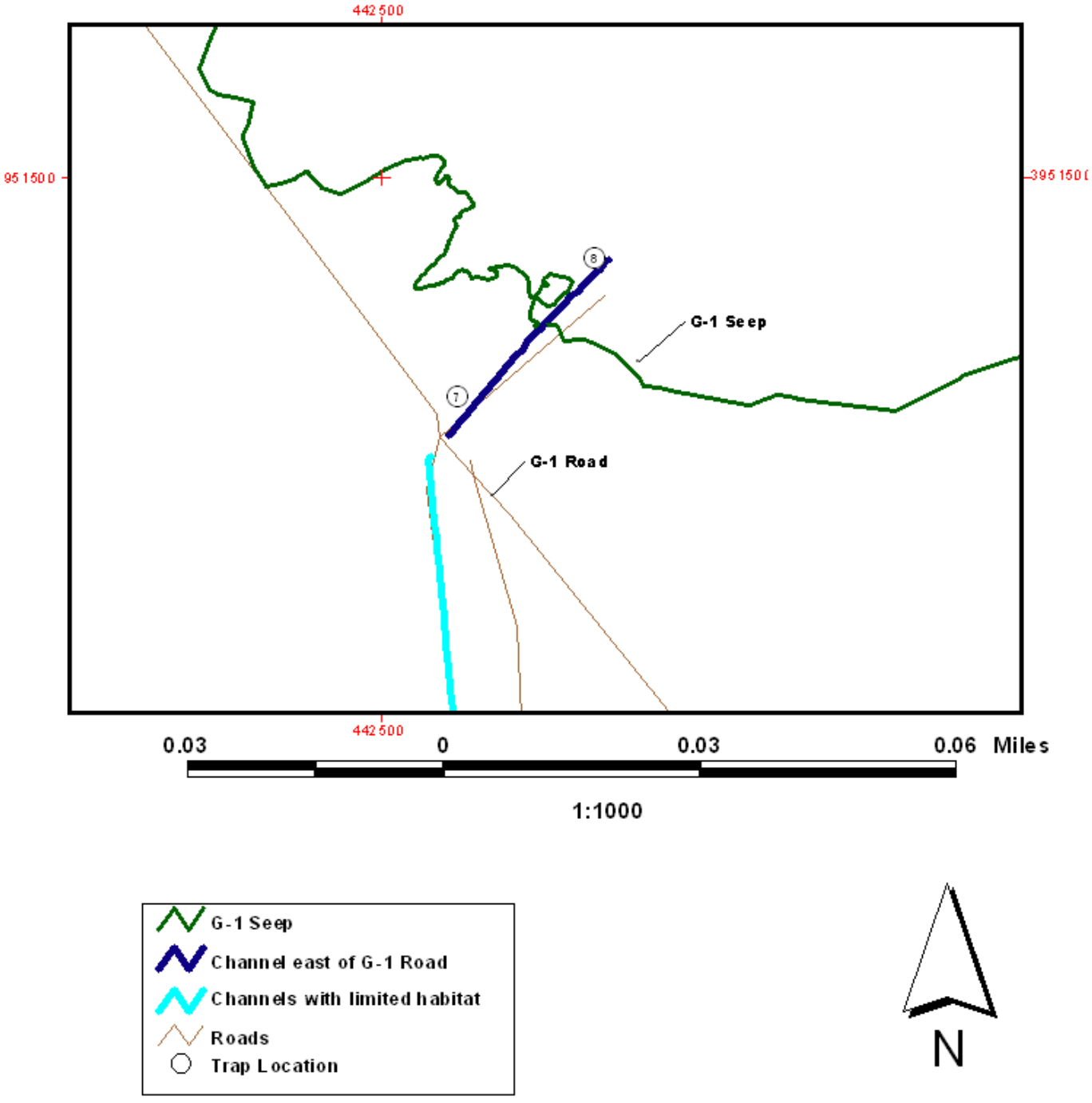
Map by Erica Nevins, Epsilon Systems Solutions 2002

Map 3. Channel east of George Road



Map by Erica Nevins, Epsilon Systems Solutions 2002

Map 4. Channel east of G1 Road



Map by Erica Nevins, Epsilon Systems Solutions 2002

4.3 Trapping Scheme

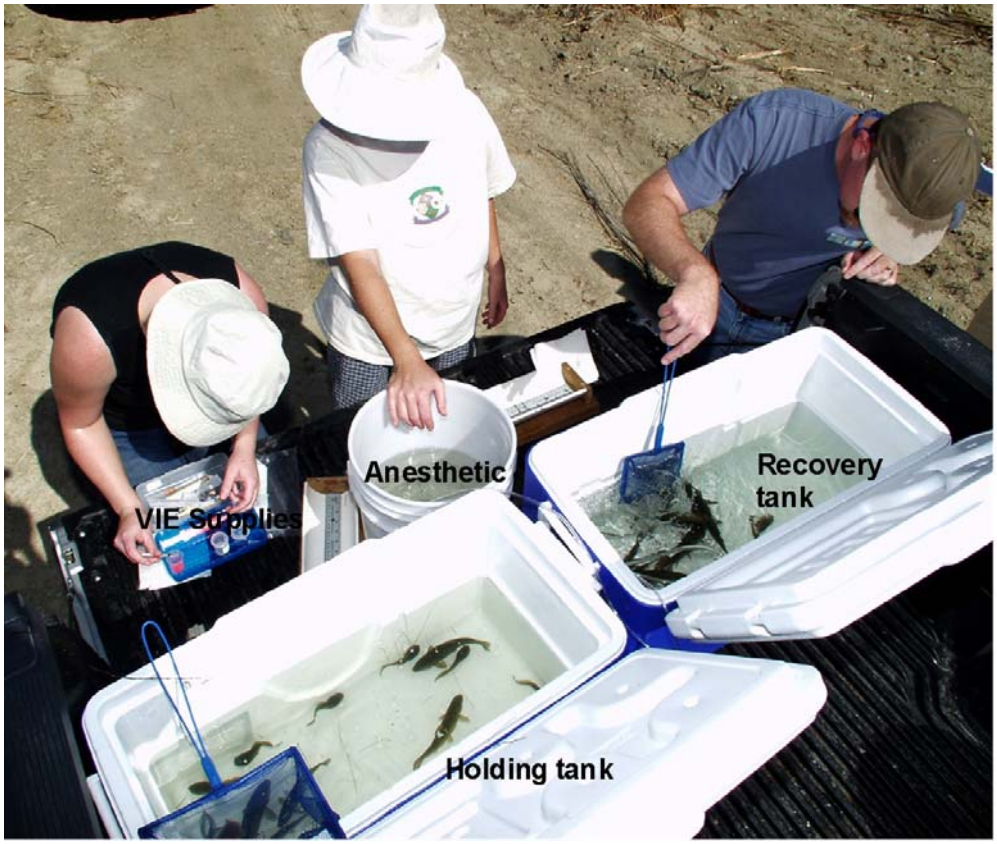
During the 2001 survey visual observations were made that some fish were attracted to the trap but could not fit into the trap opening. These observations resulted in the conclusion that possibly a significant percentage of the population were not being counted. To investigate this idea, the opening of one trap was modified from one inch by two inches wide to two inches by three inches and placed at historical trap site 4 (North channel Chub Med area) for approximately 3 hours during the day. Another trap with a smaller opening and smaller mesh was set at historical trap site 2 (Bologna Pool) for the same time period. The North Channel trap captured four very large fish and the Bologna Pool trap caught some chub fry. These results helped validate the visual observations of larger fish in the North Channel. For the 2002 survey three traps with different size trap openings were placed at each trap site. The sizes of the different trap openings were as follows: Large = 2 1/16" x 3", Medium = 1 ½" x 1 3/4", and Small = 1" x 1 3/16". The large and medium traps were made with ½-inch wire mesh and the small trap was made with ¼-inch wire mesh.

The results of the 2001 survey also suggest that fish either became "trap wise" or that the traps were set during low fish activity periods. During the 2001 census, traps were in place during low to no light periods. It is possible the chub require longer periods of light before becoming active. For the 2002 census, traps were left in place longer within day light hours. In order to circumvent the fish becoming "trap wise," there was a day of rest for each habitat between trapping events.

The trap sites were chosen with respect to the different habitat types and channel water volume. The channels were measured on 6 August 2002. The North Channel had a water volume of approximately 64,957 ft^3, George Channel's water volume was approximately 25,593 ft^3, and G1 Channel's water volume was approximately 20,160 ft^3. The volumes were divided by number of trap sites to achieve similar volumes per trap site. According to the previous calculation, the North Channel should have five trap sites; however, due to channel inaccessibility in some areas, only four trap sites were placed in the channel. Two trap sites were established within the 200-foot Chub Med portion of the North Channel as well as each end of the channel (Map 2). George and G1 Channels each have two trap sites equally dividing the channels into thirds (Maps 3-4). All trap sites were GPS'd in order to enter the positions on the GIS. Traps were not placed in the Bologna Pool due to low dissolved oxygen levels.

During the late afternoon on Sunday, 6 October 2002 traps were placed into the North Channel habitat. Three traps (one each: small, medium, and large) were baited with Special Kitty cat food and placed at each of the four sites. At noon on 7 October 2002, two 70-quart ice coolers (recovery and holding tanks) and two 10-gallon buckets (Picture 1) were filled with water from the North Channel. The traps were pulled out one at a time and emptied into the holding tank. A few fish at a time were netted and moved from the holding tank into a bucket containing Finquel (MS 222) to anesthetize them. Once anesthetized, the fish were measured, marked with pink VIE along the left jaw (Picture 2) and placed in the recovery tank, which contained fish antibiotics.

After the fish recovered they were removed with a net and returned to the channel. The number of fish in each trap was recorded. After all the traps had been retrieved and processed from the North Channel habitat they were cleaned and reset in the George and G1 Channel habitats.



Picture 1: 2002 Mark-Recapture fish processing setup.

Picture 2: VIE marking of Mojave tui chub.

During the afternoon of 8 October 2002 traps were processed beginning with the G1 Channel habitat. The tanks and buckets were filled at trap site 7 in the G1 Channel. The fish were marked with orange VIE along the left jaw in this habitat. Upon completion of trap processing along the G1 channel the containers were emptied and then refilled with water from the inlet at George Channel. The George Channel fish were marked with yellow VIE along the left jaw line. After all the fish were processed, the traps were cleaned and reset in the North Channel habitat.

On the second day of trapping in each habitat fish were processed similarly to the first day, with the exception that fish were not marked, but instead checked for VIE marks. The second day of trapping for the North Channel occurred on 9 October. The second day of trapping for George and G1 Channels occurred on 10 October (Table 2).

Table 2. Days trapped in each habitat.

	Oct 7	Oct 8	Oct 9	Oct 10
North Channel	X		X	
George Channel		X		X
G1 Channel		X		X

4.4 Fish Fatalities

During the first day of trapping at trap site 4, the small trap resulted in two fish deaths. There were no physical anomalies noted with regards to the fish. It is possible that dissolved oxygen at that site was low and caused the fish to perish. Trapping at site 4 was discontinued, due to the fatalities experienced there the first day.

On the second day of trapping in the North Channel at trap site 2, fish were found dead in the small and large traps. The small trap contained only one fish and numerous bullfrog tadpoles. The fish did not have any slime on it and was very stiff. It is possible that the bullfrog tadpoles caused the death of the fish in the small trap. The large trap contained 21 dead and 3 live fish. The expired fish appeared normal and possibly died due to low dissolved oxygen levels. All traps were set in the same manner and at the same locations on the first and second days of trapping.

4. 5 Trapping Results

The data gathered from the trapping event was entered both into an Excel spreadsheet and the POPAN-5 software. The daily trapping results for each habitat can be found in Table 3. The data was analyzed for population estimates according to habitat type. The data from G1 Channel habitat could not be analyzed, as there were no fish recaptured. Table 4 shows the results of the population calculations conducted with POPAN-5 software using the Schnabel-Darroch model. The confidence intervals are large due to the low recapture rates (Figure 5).

No spawning fish were noted during this mark-recapture survey.

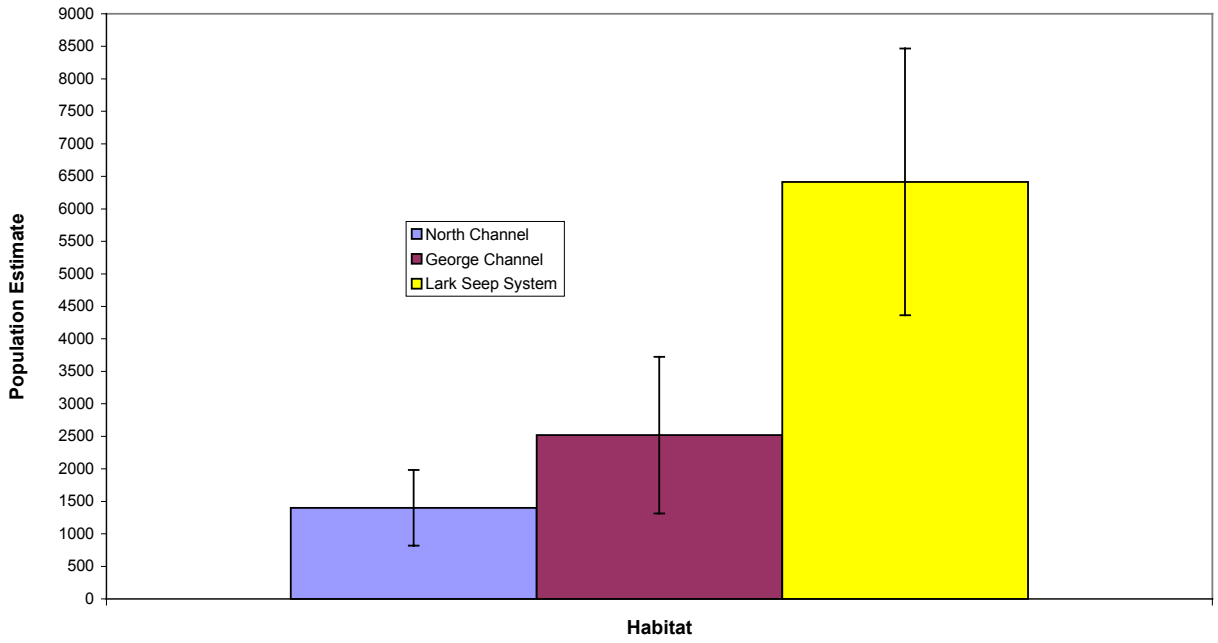


Figure 5. Mohave tui chub population estimates by habitat.

Table 3. Daily totals of the trapping event.

	North Channel	George Channel	G-1 Channel	Totals
Day 1	135	134	74	345
Day 2	50	73	41	185
Recapture	5	4	0	9
Deaths	23	0	0	23
Total	**185**	**207**	**115**	**530**

Table 4. Population estimates as calculated by POPAN-5 data maintenance and analysis software.

	Population	Confidence
North Channel	1400	583
George Channel	2518.6	1206
Lark Seep System	6414	2051.8

The survey data was analyzed and the mean sizes of fish caught in each habitat as well as an overall mean were determined (Table 5). Statistical analyses were conducted to determine if a significant difference existed in the mean size of fish between trap sites, mean size of fish caught between the large and medium traps, and the mean number of fish caught at each trap site. ANOVA tests were run for each hypothesis and the results indicated that there was no significant difference for any of the hypotheses (Table 6).

Table 5. The mean, minimum and maximum (in mm) sizes of fish captured in each habitat.

	Mean Size of Fish in mm	Minimum Size of Fish Captured	Maximum Size of Fish Captured
North Channel	140.97	69	245
George Channel	120.64	52	235
G1 Channel	112.34	45	192
Overall	126.7	45	245

Table 6. P Values of the null hypothesis

Null Hypothesis	α	P Value
H_0: There is no significant difference in the mean size of fish caught between trap sites.	0.05	0.180
H_0: There is no significant difference in the mean size of fish caught between the large and medium traps.	0.05	0.195
H_0: There is no significant difference in the mean number of fish captured at each trap site.	0.05	0.411

5.0 Discussion

Cattail removal resulted in increased open water as well as easier access during the mark-recapture survey. The VIE method of marking proved to be a success and will continue to be used in future mark-recapture surveys. The marking should give more information on movement and longevity of the chub. The POPAN-5 software was an improved method of calculating population estimates. Unfortunately, low recapture rates were still a problem, resulting in large confidence intervals that reduce the population estimates' usefulness.

In the North Channel habitat unexpected mortalities occurred which may be related to a potential problem with dissolved oxygen levels. A study has been proposed for 2003 to characterize the dissolved oxygen levels at different depths within the water column along the North Channel. This data would result in a better understanding of the dissolved oxygen cycles in the North Channel. The results will also dictate where and when traps are placed into the channel for future mark-recapture surveys. No trapping would occur in 2003 until this study is completed and dissolved oxygen level changes are better understood and modifications to trapping locations are addressed as appropriate. These modifications may include changes such as suspension of traps in the upper part of the water column or relocation to shallower sites.

Recapture rates were low again for the 2002 census. The low number of recaptured fish indicates that additional trapping days should be added to future mark-recapture surveys. Additional trapping time within each habitat may increase the number of individuals captured and recaptured; data needed to gain a more precise population estimate.

During the experiment to determine whether to use larger and smaller trap openings, chub fry were caught at the Bologna Pool. Because adult fish have not been trapped in the Bologna Pool for the past three years and the low levels of dissolved oxygen, the discovery of chub fry was unexpected. The discovery of chub fry in the Bologna Pool indicates that adult chub may still inhabit that area. However, the population data received from trapping is not considered valuable enough to warrant risking the danger (i.e. low dissolved oxygen levels) that is inherent in trapping in the Bologna Pool. Also, the Bologna Pool is considered to have a separate population that seldom, to never, integrates with the North Channel population due to the fish barrier at the culvert on Water Road.

Upon visual observation a large population of Bullfrogs exists within the North Channel habitat. Bullfrogs are voracious feeders, and have been known to consume fry. A Bullfrog eradication program needs to be developed at NAWS, China Lake. The small traps used during the mark-recapture survey attracted many Bullfrog tadpoles. Using the small traps on a regular weekly or monthly basis may be a possible Bullfrog eradication method. Another potential method of eradication would take place at night with a high power light that can pick out the frogs to be exterminated using a gig or pellet gun. Due to security measures at the NAWS, China Lake a gig would be the preferred tool. A small boat would be needed to patrol the channels in search of frogs to eradicate.

6.0 Future Projects

1. Additional 24-hour water meters should be placed along the Lark Seep System, preferably in the George and G-1 Channel habitats.

2. Tamarisk removal will need to be continued in 2003. The "cut stump and herbicide application" method should be tested for its effectiveness in controlling tamarisk in and around the Lark Seep System.

3. Complete dissolved oxygen study of the North Channel habitat.

4. Complete topographical study of channel depths.

5. Implementation of a Bullfrog eradication program.